Premolar Cementum and Noncementum Lengths As Potential Indicators of Age for Beavers, *Castor canadensis* (Rodentia: Castoridae)

ALLAN E. HOUSTON
Ames Plantation, Agricultural Experiment Station, The University of Tennessee, P. O. Box 389, Grand Junction, Tennessee 38039-0389

AND

MICHAEL R. PELTON
Department Forestry, Wildlife, and Fisheries, The University of Tennessee, Knoxville, Tennessee 37901-1071

ABSTRACT—Jaws from 28 beavers (*Castor canadensis*), ≥4 years old as determined from cementum annuli on premolars and molars, were collected in west Tennessee. An exponential model predicting age was developed based on the independent variables cementum length and noncementum length as measured along the estimated, maximum longitudinal centerline of cross-sectioned premolars: $AGE = 0 + 6.1784 * e^{(-0.1037*NONCEMEN)} + 2.6513 * e^{(0.1119*CEMENTUM)}$.

Several methods of aging beavers have been attempted with varying degrees of accuracy, including pelt size (Buckley and Libby 1955), tail dimensions, total body mass, skull measurements (Patric and Webb 1960), and baculum size and mass (Friley 1949). Probably the most accurate method was developed by van Nostrand and Stephenson (1964) using tooth eruption and closure of basal openings of premolars and molars for beavers up to 3 years old, and cementum layering in premolars and molars for specimens ≥4 years. Larson and van Nostrand (1968) further refined this technique to include criteria dealing with cementum deposition around basal openings. They noted that age estimations may be complicated by multi-annual cementum layering, but that the ratio of cementum to noncementum on molars and premolars might be used to estimate age in older specimens.

Our objective was to use premolar cementum length (aggregate of all annual cementum depositions) and noncementum length (remains of the original tooth) as independent variables to evaluate a model for estimating age of beavers ≥4 years.

METHODS

This study was conducted in the upper headwater basin of the North Fork of the Wolf River in west Tennessee, largely on the Ames Plantation. From November 1984 through May 1985, beaver jaws from 169 beavers were collected from legal trapping efforts on approximately 1,619 ha of the watershed.

Molars and premolars from lower mandibles were extracted and cleaned. If tooth basal openings indicated a specimen to be ≥4 years old, age was determined by grinding the lingual surface of premolars or molars with a 120-grit stone to expose longitudinal cross-sections. Ground surfaces were polished with a 400-grit emery cloth and cementum layers were carefully counted using hand-held magnification (Larson and van Nostrand 1968). Twenty-eight beavers, ≥4 years old as aged in this manner (Table 1), provided the samples (i.e., dependent variables) for our study.

Premolar cementum length and noncementum length were measured to the nearest millimeter along the estimated maximum longitudinal cross-sectional centerline of one premolar per specimen (Fig. 1). An exponential model predicting age in years was developed by combining a growth curve for cementum length and a decay curve for noncementum, using nonlinear regression (PROC NLIN) and the multivariate secant method (DUD) to set initial parameters (SAS Institute, Inc. 1985). Intercept was specified at zero to prevent predicted ages from dipping below zero. An "r^2 like" statistic was calculated by taking [1 - (residual SS/corrected total SS)].

RESULTS AND DISCUSSION

The following model was developed using cementum length and noncementum length of premolars as independent variables:

$$AGE = 0 + 6.1784 * e^{(-0.1037*NONCEMEN)} + 2.6513 * e^{(0.1119*CEMENTUM)}.$$

The "r^2 like" statistic was 0.93. The predicted curves are combined to produce a response surface (Fig. 2).

Our data were obtained from specimens on the headwaters of a single watershed. Although beavers can travel considerable distances, we assumed our sample represented only a small region. The study area may not fully represent variation existing range-wide or within adjacent watersheds. It is possible that genetic differences and dietary regimes will yield different tooth size, wear, and cementum accretion

Table 1. Age, as estimated by cementum annuli, cementum and noncementum length, measured to the nearest millimeter along the maximum longitudinal cross-section of one premolar per specimen, and predicted ages and residuals for beavers captured in west Tennessee, November 1984 through May 1985.

Specimen	Age	Cementum	Noncementum	Predicted Age[1]	Residual
1	4	3	22	4.34	-0.34
2	4	3	22	4.34	-0.34
3	4	1	24	3.48	0.52
4	4	3	22	4.34	-0.34
5	4	2	21	4.02	-0.02
6	4	3	21	4.41	-0.41
7	4	3	19	4.57	-0.57
8	4	1	24	3.48	0.52
9	4	1	24	3.48	0.52
10	4	2	20	4.09	-0.09
11	4	1	22	3.60	0.40
12	4	2	22	3.95	0.05
13	4	3	21	4.41	-0.41
14	5	4	14	5.59	-0.59
15	5	6	16	6.36	-1.36
16	5	5	20	5.42	-0.42
17	7	6	19	6.05	0.95
18	8	7	13	7.41	0.59
19	8	9	11	9.23	-1.23
20	9	9	10	9.45	-0.45
21	9	8	13	8.10	0.90
22	9	9	8	9.95	-0.95
23	9	9	9	9.69	-0.68
24	10	8	9	8.92	1.08
25	10	9	11	9.23	0.77
26	10	8	11	8.46	1.54
27	11	10	10	10.31	0.69
28	12	12	10	12.35	-0.35

[1] $AGE = 6.174 * e^{(-0.1037 * NONCEMEN)} + 2.6513 * e^{(0.1119 * CEMENTUM)}$.

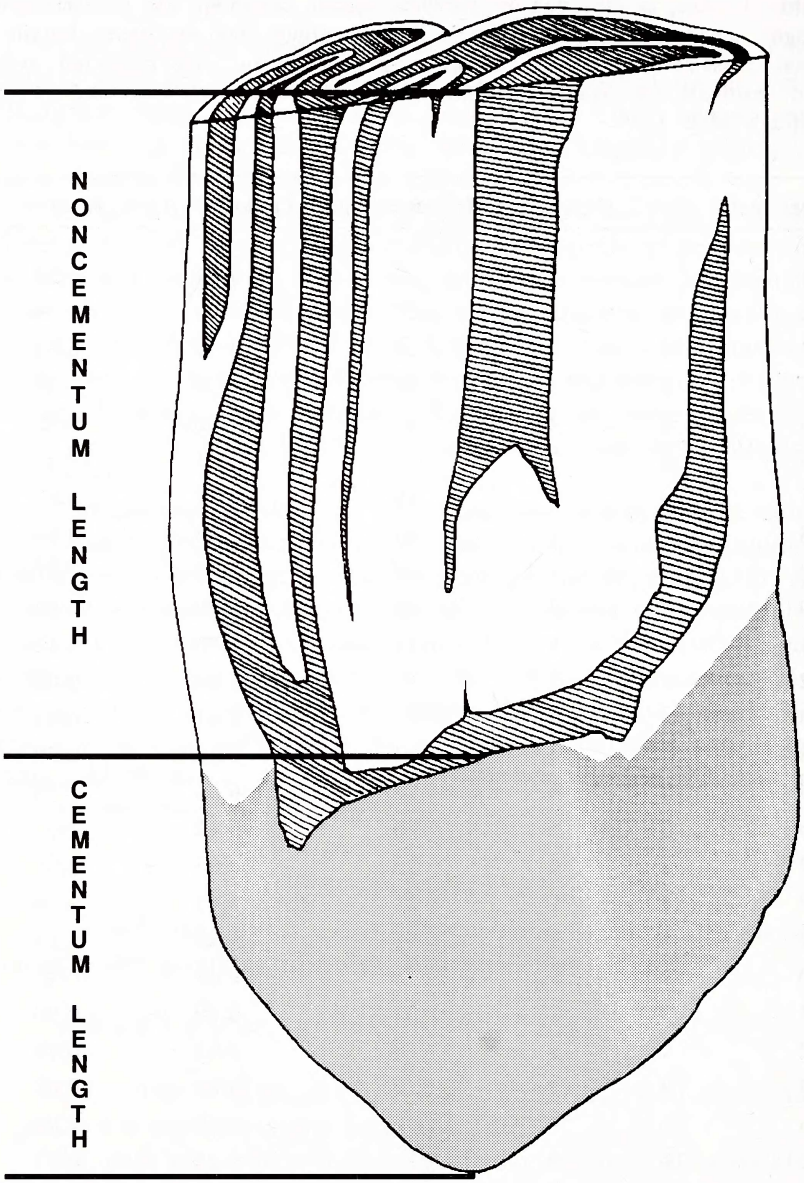

Fig. 1. Schematic representation of cementum length and noncementum length as measured along longitudinal cross-sections of premolars for beaver.

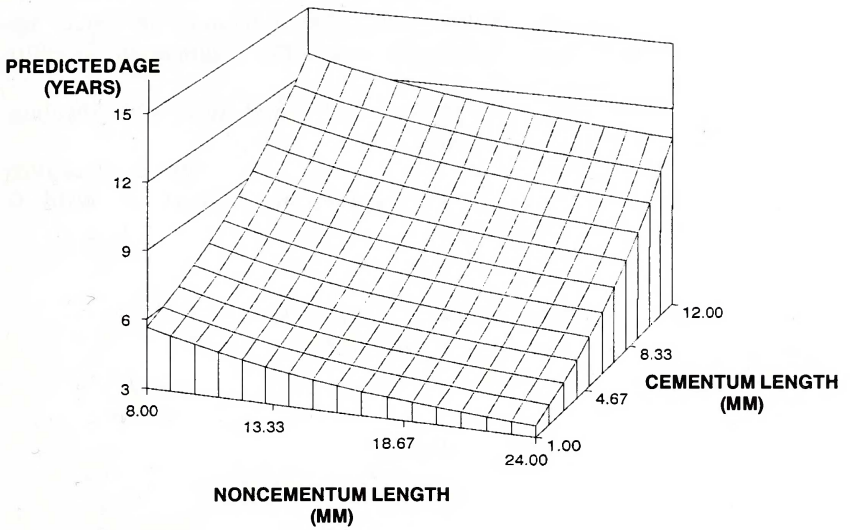

Fig. 2. Response surface of an exponential model predicting age of west Tennessee beaver using cementum length and noncementum length measured along the estimated maximum longitudinal cross-sections of premolars as independent variables.

patterns. Comparative study is needed to document potential variation of these criteria. Also, the method should be validated using known-age specimens. However, these results suggest that this technique could be developed as a reliable method to age beavers.

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